IDC Performance Report
September 3 - 16, 1994

IDC Staff - October 4, 1994

INTRODUCTION AND SUMMARY

The purpose of this report is to summarize the operational and seismological performance of the International Data Center (IDC) for the period September 3 - 16, 1994. The IDC is not an operational system; rather, it is a developmental system that is changing rapidly in anticipation of the full-scale portion of GSETT-3 beginning in 1995. This report is an internal document for monitoring the IDC in order to identify and fix problems in a timely fashion. Text that is new or changed since the last report is highlighted in italics, and unchanged text appears in plain type.

The GSETT-3 Alpha network presently consists of nine arrays in Europe, Australia, the U.S., and Canada as well as nine 3-component stations in Canada, Australia, Antarctica and Siberia. The Yellowknife array in Canada began transmitting data to the IDC during the current reporting period. The Beta network consists of six stations of the German Regional Seismograph Network and a scattering of open stations in countries that have committed to participate in GSETT-3.

The IDC increased the number of "data days" to 3 per week at the beginning of September. A data day is a day for which waveforms are retrieved from Beta stations and for which waveform data and event solutions are reviewed by analysts. Data import has quadrupled since at the onset of Version 2 because of the increase in the number of Alpha stations.

There were 119 events in the Reviewed Event Bulletin for the 6 data days of this reporting period (20/day). Eight percent of these events were added during analyst review.

OPERATIONAL SUMMARY

A. GSETT-3 Stations and Communications

The Alpha network for the current reporting period consists of 5 arrays in Europe, two in Australia, one in the Canada, and one in the U.S., along with five 3-component stations in Canada, two in Australia, one in Antarctica and one in Siberia. The Canadian array, with a temporary station code YKR8, became a part of the Alpha network and began transmitting data to the IDC on September 7. Stations in the current Alpha network appear in Table 1 and Figure 1.

The numbers of elements for arrays reported in Table 1 have changed slightly from previous reports in order to clarify the definition of array elements. The number of elements is now taken to be the number of distinct sites within an array. For some arrays, more than one channel is available from a given site (e.g., horizontal components or channels with a different pass band).

Communication links are now in place between the IDC and the Australian, Canadian, Chinese, Norwegian, Russian and U.S. NDCs. Data were transmitted to the IDC from all but the Chinese and Russian NDCs during the current period.

The Beta network (Table 2 and Figure 1) consists of 6 stations of The German Regional Seismograph Network (GRSN) and one station in Hungary. There is also a scattering of 12 open stations in southern Europe, western Russia, and the western Pacific, one in southeast Australia, and one off the Atlantic coast of North Africa that are presently used as Beta stations. Waveforms are retrieved from Beta stations based on a distance and probability of detection threshold. Beta data are also available from the Canadian NDC, but the IDC has not yet developed an AutoDRM retrieval system to take advantage of these data.

Table 1: Alpha stations nominally part of the current version of GSETT-3

Code	Lat.	Lon.	Name	Country	Type	# of elements
ARA0	69.53	25.51	ARCESS Array	Norway	Array	25
ARMA	-30.42	151.63	Armidale	Australia	3C	
AS12	-23.67	133.90	Alice Springs Array	Australia	Array	19
DRLN	49.26	-57.50	Deer Lake	Canada	3C	
FCC	58.76	-94.09	Fort Churchill	Canada	3C	
FIA0	61.44	26.08	FINESS Array	Finland	Array	16
GEC2	48.85	13.70	GERESS Array	Germany	Array	25
LY06	42.77	-109.56	Pinedale Array	U.S.A.	Array	13
MAW	-67.60	62.87	Mawson	Antarctica	3C	
MBC	76.24	-119.36	Mould Bay	Canada	3C	
NRA0	60.74	11.54	NORESS Array	Norway	Array	25
PDY	59.63	112.70	Peleduy	Russia	3C	
SPA0	78.18	16.37	Spitsbergen Array	Norway	Array	9
WALA	49.06	-113.91	Waterton Lakes	Canada	3C	
WHY	60.66	-134.88	Whitehorse	Canada	3C	
WOOL	-31.07	121.68	Woolibar	Australia	3C	
WRA	-19.94	134.34	Warramunga Array	Australia	Array	20
YKR8	62.49	-114.61	Yellowknife Array	Canada	Array	22

Table 2: Beta stations nominally part of the current version of GSETT-3

Code	Lat.	Lon.	Name	Country	Type	# of elements
AFI	-13.91	-171.78	Afiamalu	Western Samoa	3C	
AQU	42.35	13.40	L’Aquila	Italy	3C	
ARU	56.43	58.56	Arti	Russia	3C	
BFO	48.33	8.33	Black Forest	Germany	3C	
BRG	50.87	13.95	Berggiesshuebel	Germany	3C	
BUG	51.45	7.26	Bochum	Germany	3C	
CLZ	51.84	10.37	Clausthal	Germany	3C	
CTAO	-20.09	146.25	Charters Towers	Australia	3C	
KIV0	43.96	42.70	Kislovodsk Array	Russia	Array	4
KONO	59.65	9.60	Kongsberg	Norway	3C	
MAJO	36.54	138.21	Matsushiro	Japan	3C	
MOX	50.65	11.62	Moxa	Germany	3C	
NWAO	-32.93	117.23	Narrogin	Australia	3C	
OBN	55.12	36.60	Obninsk	Russia	3C	
PAB	39.55	-4.35	San Pablo	Spain	3C	
PSZ	47.92	19.89	Piszkes	Hungary	3C	
RAR	-21.21	-159.77	Rarotonga	Cook Islands	3C	
SNZO	-41.31	174.70	South Karori	New Zealand	3C	
TBT	28.68	-17.91	Taburiente	Spain	3C	
TNS	50.22	8.45	Taunus	Germany	3C	
VSL	39.50	9.38	Villasalto	Italy	3C	

A basic requirement for achieving a consistent detection threshold is the reliable operation of stations of the Alpha network. For Alpha stations, data availability is defined as the portion of the reporting period for which data are available at the IDC (Figure 2). In the case of new stations, the percentage is normalized to account for the number of full days the station was part of the Alpha network. *Because the IDC cannot directly monitor offsite problems affecting data flow, Figure 2 reflects any problems that interfere with the acquisition, transmission, receipt, and storage of Alpha data at the IDC. However, it serves as a useful tool to identify problems with stations and communications.*

Station malfunctions at FCC and MBC caused loss of data ending September 8 and 4, respectively, and contributed to the results in Figure 2. Several non-station problems also degraded data availability in Figure 2. Difficulties with data transmission programs at the Australian NDC reduced data availability for Australian and Antarctic stations. No data were received from LY06 from September 4-6 due to failure of some computers at the U.S. NDC because of failure of air conditioning. A defective power supply in the NRA0 disk at the Norwegian NDC caused the loss of data at the IDC for that array from September 3-5. Data from station PDY remained unavailable at the IDC because of problems with communications and the sensor.

For Beta stations, *data availability* is defined as the percentage of days on which data were successfully retrieved by an automatic polling procedure and thus measures the operation of the station and communications together. The Beta polling procedure attempts to retrieve data from each station once a day, retrying each station at intervals of 2 minutes until it is either successful or reaches the maximum limit, presently 4 attempts. *The malfunction of the program that polls Beta stations was related to the conversion from SunOS to Solaris operating system and was repaired during this period. Statistics on the availability of data from Beta stations will not be available until the next report (Figure 3 omitted).*

A critical requirement for maintaining the detection threshold of the GSETT-3 System is that data be promptly available. The GSE target time for data availability at the IDC is less than five minutes after recording. The deadline for inclusion in automatic processing for the Alpha Event List (AEL) is about 50 minutes after recording, and for inclusion in the Alpha-Beta Event List (ABEL), about 3 hours and 50 minutes. Data timeliness will not be assessed until tracking is included in the Alpha protocol and disk loop management software is implemented at the IDC (Figure 4 omitted).

Other station problems are summarized in Table 3. *The GEC2 array element failure was caused by thunderstorm activity. Timing errors of 7 to 10 seconds have been reported for WRA, MAW, and MBC. the timing error for MBC was fixed on September 15 when the Alpha data transmission program was restarted with a new time correction. The timing problem at WRA may be the result of software designed to remove data dropouts. Long-period DC drift was identified on one element at the YKR8 array.*

Table 3: Technical problems with seismic stations

Station	From	To	Problem
FCC	08/23/94	09/08/94	Station failure
GEC2	09/01/94	09/05/94	GEC2 (element) dead
LY06	09/04/94	09/04/94	system outage at AFTAC
MAW	09/06/94		Timing error
MBC	09/01/94	09/05/94	Power failure
MBC	09/04/94	09/15/94	Timing error
PDY	02/13/94		Unreliable communication
PSZ	07/11/94		Data not received
WOOL	08/03/94		Glitches on channel be
WRA	09/06/94		Timing error
YKR8	09/16/94		Large drift on YKW4/bn

The success of the Alpha-Beta network concept is dependent on reliable communications with Beta stations. Figure 5 shows for each station the percentage of successful data retrievals by event using the program WaveMaster. A successful retrieval is one that retrieves all the data specified, for example all three broad-band channels of a given site. Zero values for stations ARU, KIV0 and OBN are not valid, because programs other than WaveMaster were used to retrieve their data, and statistics were not stored in the database. For PSZ, no data is being received at the IDC. *The median success rate for retrievals from Beta stations declined from about 58% in the last report to 40% for the current period. The median success rate for the 6 GRSN stations was greater than 80%, whereas it was less than 30% for dialup stations. Requests were made for data from SNZO and VSL, but with no success.* For dialup Beta stations, the success was lower than normal, because retrieval attempts were not requeued sufficiently often when the modem at the IDC was busy.

Figure 6 shows the number of events for each station for which the IDC attempted to retrieve data and their outcomes. The number of waveforms requested from Beta stations is a function of their proximity to Alpha stations as well as to seismicity and of the criteria used to initiate requests. The black portion of each bar shows the number of phases that were defining in the REB. *The large differences between the number of retrieved events for a given station and the number that were ultimately used in the REB is largely a consequence of the difference in event definition criteria between the AEL and REB. Stations in the western Pacific (AFI, RAR, CTAO and MAJO) and station KONO in Norway contributed the most defining observations in the REB. Data requests for GRSN stations are still based on events in the AEL with one or more Alpha stations. However, the current analysis criterion for the REB requires 2 Alpha stations. As a consequence, relatively few GRSN data are included in the REB.*

B. IDC Facility and Logistical Factors

Facility operation was normal.

C. IDC Hardware Infrastructure

The Epoch optical disk jukebox continued to experience problems related to the increased load that has resulted from a large volume of Alpha data currently received at the IDC.

D. IDC Software Infrastructure

Clocks on some of the multiprocessor SPARCstations used for Alpha data acquisition and signal processing have become desynchronized from the network time standard. Large jumps in time have caused problems with the scheduling of automatic processing, which are temporarily overcome by re-synchronizing clocks using a cron process.

The user and program interface to the Oracle 6.037 database, orasrv, which is used for seismic operations, hung several times during this period, disrupting automatic processing of seismic data.

E. IDC Seismic Data Processing

Continuous data transmission to the IDC quadrupled from from 0.5 Gigabytes(GB)/day in mid-June to over 2.0 GB/day during the current period (Table 4). This is the result of the growing number of Alpha stations and the import of continuous data. Retrieval of Beta data doubled from that of the last reporting period because of an increase in the number of data days from 3 to 6 per week. The GSETT-3 waveform archive presently uses 51% of the capacity of the Epoch optical disk jukebox (Table 5). Table space allocated for IDC operations, excluding other database accounts, and the space remaining are also shown in Table 5.

Table 4: Volume of data received at IDC

	Current (MB/day)	Previous Average (MB/day)
Alpha Stations	2039.5	276.1
Beta Stations	12.5	19.1

Table 5: Volume of data stored at the IDC

	Allocated (MB)	Remaining (MB)
Waveform Archive	127000	123000
Database table space	2385	1379

The bulletin and waveform data that were exported from the IDC during the current period are summarized in Table 6.

Table 6: Data exported from the IDC

Category	# of Sessions	# of Events	# of Waveforms
E-mail	404	159	0
X Windows	2	103	0

The IDC strives to complete the AEL and ABEL within 1 hour and 4 hours, respectively, of event origin time. *Two of the six data days during this reporting period met these target times (Figure 7). Delays on September 10 were the result of some processes not recovering after one operations computer was rebooted. Delays on September 14 were caused by overflow of a disk that was critical to automatic processing, followed by a failure of ISIS, which handles interprocess communication. Delays of the automatic event lists on September 3 and 8 were not documented.*

The IDC attempts to complete the Reviewed Event Bulletin (REB) within 2 days following the end of each data day, *which varies from 48 to 72 hours after the event origin time. Figure 7 shows the time that events are saved in the REB database account relative to the event origin time. The target times were generally met during this reporting period.*

F. GSETT-3 System Changes

The number of data days has been increased to 3 per week, compared to 2 per week during Versions 0 and 1. (A data day is a day for which Beta data are retrieved and for which analysts review waveforms and event solutions.)

SEISMOLOGICAL SUMMARY

A. Station Processing

Alpha Station Performance

Figure 8 shows the phase detection rate for Alpha stations. *Many of the unassociated detections at SPA0 resulted from a seismic survey with a 2660 cu. in. airgun in the area of 79 deg North, 26 deg East for several days beginning September 9. The European arrays ARA0, GEC2 and SPA0 recorded the most detections and also the most defining phases per day in the ABEL (80/day).*

Phases detected but unassociated by the automatic system are presented in Figure 9. *The large numbers for SPA0 were caused by a seismic survey off the east coast of Spitsbergen.* Sx detections, which tend to be associated with noise glitches, and other sources of noise (N) were the most common.

Beta Station Performance

The current period does not provide a measure of the quality of signal processing at Beta stations, because an insufficient number of waveform segments were retrieved by the IDC (Figure 10). *The daily average for KIV0 is not valid because KIV0 had been used as an Alpha station in earlier versions.* The numbers of unassociated phases and their tendency to be unidentified were typical for these stations (Figure 11).

Gamma Data Availability

Table 7 summarizes the Gamma data that were received at the IDC for the reporting period. Note that the table includes only data that were available at the time of compiling these statistics, about 4 days after the end of the period.

Table 7: Summary of reported Gamma data						
NDC Country	All days during fortnight			Data days only during fortnight		
	# of events	min ML	max ML	# of events	min ML	max ML
Switzerland	12	2	4.9	8	2	4.9
Spain	15	0	0	7	0	0
Japan	22	0	6.4	7	0	4.3

Automatic Signal Processing

Changes to phase timing, identification and association with events take up much of an analyst’s time, and an important objective of automatic processing is to minimize the number of changes required. Table 8 shows some of the changes to arrivals during the analyst review as reported in the Reviewed Event Bulletin (REB). The percentages of all phase changes are relative to the total number of defining phases in the REB, except for retimed phases, which is relative to the number of time-defining phases.

Table 8: Changes of phases during the analyst review				
Type of Change	Current		Previous Total	
	# of Phases	% of Def	# of Phases	% of Def
Unmodified	780	84.2	8736	52.4
Retimed	58	6.6	3000	20.9
Added	259	28.0	3854	23.1
Associated	433	46.8	7583	45.5
Renamed	210	22.7	4667	28.0
Disassociated	2242	242.1	15151	90.9

B. Event Bulletins

Automatic Event Processing

Table 9 shows the number of events in the AEL, ABEL and REB for the current reporting period, with percentages normalized to the number in the REB. The total number of events in the AEL is the sum of the events with one station and those with 2 or more stations. The total number of events in the ABEL is shown as "all" and includes one-station events. The number shown in the second ABEL row shows potential REB events. These include events that had two or more stations in the ABEL and events that have one station in the ABEL but have phases from at least one additional station during analyst review, and are therefore in the REB. *The program which generates Table 9 has not yet been modified to account for the 3-P criterion for analysis, and the ABEL (all) and ABEL rows show events with one or two stations, respectively. The high rate of* "*rejected*" *events is a consequence of using a liberal event definition criterion for the automatic event lists (1 station for the AEL and ABEL (all)) and a more conservative criterion for the REB (3 stations).*

Table 9: Number of events in the AEL, ABEL and REB				
Category	Current		Previous Total	
	# of Events	% of REB	# of Events	% of REB
AEL (1 station)	546	458.8	5808	207.7
AEL (>= 2 station)	499	419.3	2651	94.8
ABEL (all)	1103	926.9	9148	327.2
ABEL (>=2 stations)	625	525.2	4487	160.5
REB (all, >=3 stations)	119	100.0	2796	100.0
With Beta Data	36	30.3	1498	53.6
Added	9	7.6	236	8.4
Rejected	466	391.6	1708	61.1
Unmodified	0	0.0	6	0.2
Split Repaired	40	33.6	215	7.7

Changes in ABEL epicenter locations for the REB are shown in Table 10. The largest number of changes were those in which the nearest station was more distant than 2000 km and involved epicentral shifts of more than 50 km.

Distribution of Epicenters

Figure 12 shows epicenters in Europe from the REB for the current reporting period. Most events occurred in areas that had been active earlier during GSETT-3. These active areas include the mining districts in Estonia, Central Europe, and Northern Fennoscandia. Because defining phases from 3 stations (at least 2 Alpha stations) were required for analyst review, fewer small events in Europe are included in the REB for this period than for a comparable period during Versions 0 and 1.

Table 10: Changes of hypocenters between the ABEL and REB					
Change (km)	Nearest station (km)	Current # Ev	Current % REB	Total # Ev	Total % REB
Epicenter: < 10	< 200	0	0.0	196	7.0
Epicenter: 10-50	< 200	1	0.8	264	9.4
Epicenter: > 50	< 200	1	0.7	53	1.9
Epicenter: < 10	200-2000	4	3.4	139	5.0
Epicenter: 10-50	200-2000	27	22.5	579	20.7
Epicenter: > 50	200-2000	14	11.6	387	13.8
Epicenter: < 10	> 2000	0	0.4	12	0.4
Epicenter: 10-50	> 2000	4	3.2	49	1.7
Epicenter: > 50	> 2000	59	49.7	880	31.5
Depth	< 200	0	0.3	21	0.8
Depth	200-2000	8	6.9	123	4.4
Depth	> 2000	24	20.2	231	8.2

The world-wide distribution of epicenters for the current period follows the familiar pattern of global seismicity (Figure 13). preventing reduction of location uncertainties. In general, the application of more conservative event definition criteria than used during Versions 0 and 1 and additional stations in the south Pacific and Australia has reduced the estimated uncertainties of events in the western Pacific relative to earlier periods. The number of events in that region has not increased relative to the earlier GSETT-3 versions, because the analyst review criteria are more restrictive during Version 2.

This section discusses moderate-size and large events that may have been missed by the IDC. Figure 14 shows the predicted capability of the Alpha network for the current period. The predicted capability is based on 3 P detections, the current analyst review criteria. However, it is slightly more conservative in that it assumes that all 3 detections came from Alpha stations; the actual criterion is that at least 2 stations are Alpha stations. In previous reports, the predicted capability was based on 2 P detections, one of which could have been from a Beta station, the event criteria for Versions 0 and 1.

Note that the predicted capability is calculated for the actual availability of Alpha data at the IDC for the current reporting period. Because a number of the Alpha stations had low availability, the predicted capability is significantly lower for this period than would be achieved with the same network with higher data availability.

The Quick Epicentral Determination (QED) was the only global reference bulletin available at the time of preparation of this report. *Figure 14 and Table 11 show six events in the QED that were not matched with events in the REB for the current reporting period. The largest event, m_b 5.7, on Septeber 6 was in fact contained in the REB, (origin time 16:38:18,* 21.7^o *S,* 177.6^o *W, 178 km depth), but was not matched with the QED because of the difference in focal depth. Three events in the Indian Ocean, Indonesian arc and New Zealand occurred on September 3, a day when no data were available at the IDC for WOOL or MAW, and only 40% for ARMA. Two other events occurred near New Zealand on September 6 when WRA and MAW suffered timing problems that precluded their use.*

Table 11: Events in other bulletins but not in the REB

Date	Time	Latitude	Longitude	Depth(km)	m_b	Bulletin
94/09/06	12:29:31.0	-34.3	179.5	33	5.1	QED
94/09/06	13:27:18.0	-34.1	179.5	33	4.7	QED
94/09/06	16:37:57.0	-23.0	-176.9	33	5.7	QED
94/09/03	09:41:23.0	-35.7	178.8	160	5.2	QED
94/09/03	13:28:08.0	-8.7	105.9	33	5.1	QED
94/09/03	03:43:58.0	-27.9	76.1	10	5.2	QED

Location uncertainties

The main purpose of the Beta network is to improve the accuracy of located events. Tables 12 and 13 compare the estimated error ellipses (lengths of the semi-major axes) for which Beta stations were and were not available. The results in the tables are grouped according to the distance of the nearest defining station.

Table 12: Median semi-major axes of error ellipses for events with defining phases from Beta stations

Distance Range	AEL		ABEL		REB	
	Median	#	Median	#	Median	#
< 200 km	37.0	2	37.0	3	15.7	3
200-2000 km	52.5	19	78.9	30	45.2	26
> 2000 km	793.5	52	972.1	57	62.0	11

Table 13: Median semi-major axes of error ellipses for events with *no* defining phases from Beta stations

Distance Range	AEL		ABEL		REB	
	Median	#	Median	#	Median	#
< 200 km	62.7	20	34.4	34	14.4	2
200-2000 km	163.7	160	163.7	181	36.8	38
> 2000 km	1918.7	284	1915.1	306	228.0	39

Depth Estimates

Focal depths were restrained by the analyst for most events in the REB for this reporting period (Figure 15). *However, the percentage of events either unconstrained because of adequate P and S phase data, or constrained by depth phases remains higher than the norm for previous versions of GSETT-3 due to growth of the Alpha network.*

Figure 16 compares the IDC depth solutions that were unconstrained with QED depths, both constrained and unconstrained. *The USGS and IDC values for all of the 10 events shown agreed reasonably well, except the one at an IDC depth of 25 km versus 88 km by the USGS. The IDC value had a*

90% confidence of plus or minus 6 km determined from 16 phases, 7 of which were depth phases for which stations ranged from 39 to 87 degrees away. The USGS value was determined by 13 phases, and no depth phase constraints were used.

Magnitude Estimates and Distributions

During Versions 0 and 1 of the IDC, magnitudes were not recalculated following analysis. Rather, magnitudes determined for the ABEL were copied into the REB magnitude field. The procedures for calculating REB magnitudes are under revision (Figures 17 and 18 and Table 14 omitted).

Use of Stations in Bulletin Production

Differences in the geographical distributions of seismic events and of stations of the GSETT-3 network contribute to variations among the stations in their use in the solutions of event lists and bulletins. Other factors related to the detection capabilities of individual stations also contribute to these variations. Figures 19 and 20 show the frequency of use of data from each of the Alpha and Beta stations for this reporting period. Bars show the fractions of events at local, regional, and teleseismic distances for which each station contributed detected phases associated with the REB event solutions, and the numbers above the bars shows the number of events in that distance range.

All Alpha stations except PDY were used during this period. Stations most useful at teleseismic distances were arrays (Figure 19). Low percentages for REB use of MAW, MBC, and WRA at teleseismic distances was due to the timing errors described in the section on Stations and Communications. *For YKR8 and WRA, inappropriate parameter files were used to calculate beams prior to September 12.*

The generally low use of Beta stations for this period (Figure 20) was due to inadequate scheduling of a single available modem, as described in Stations and Communications above.

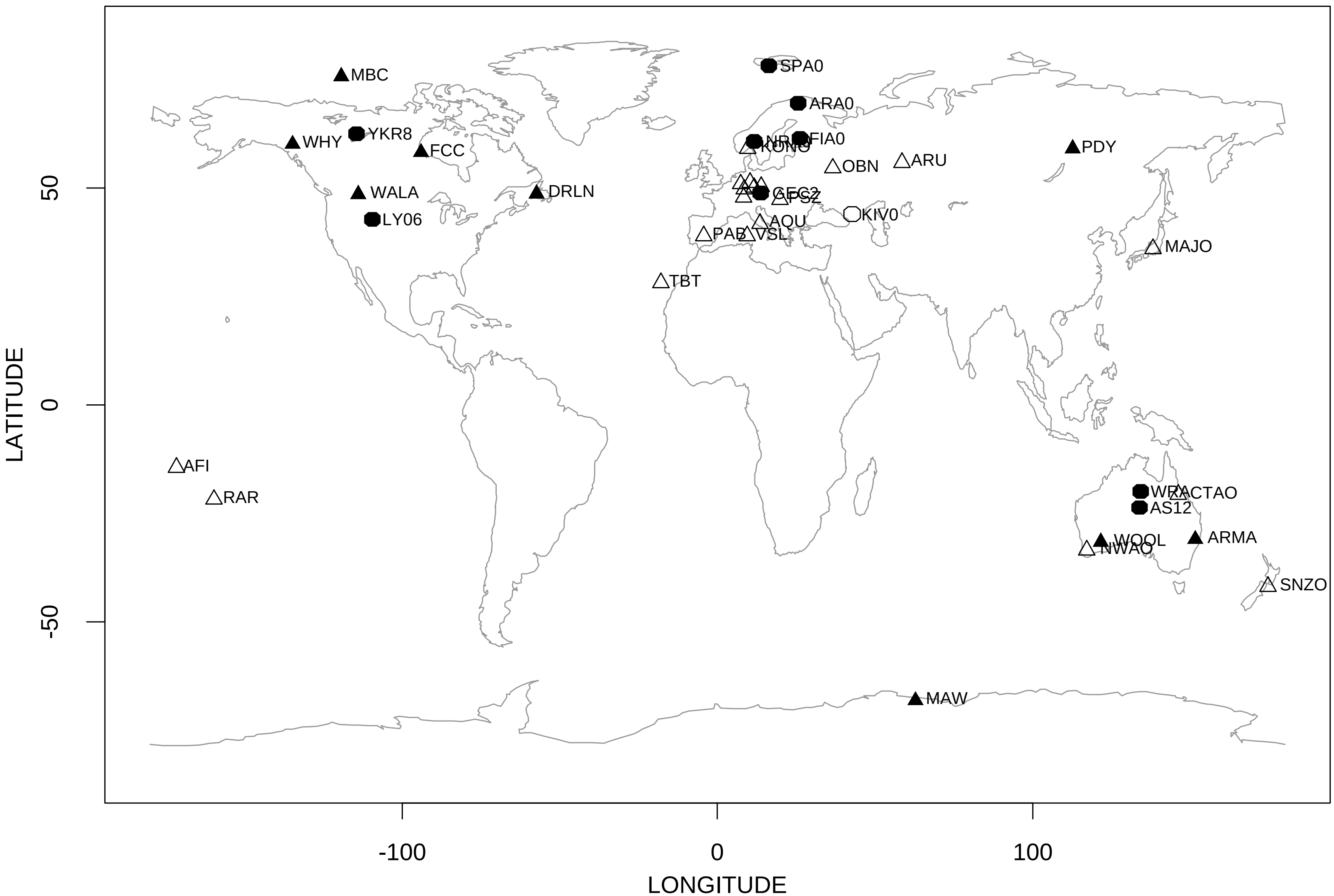

Figure 1. Geographical distribution of stations nominally part of the current version of GSETT-3. Alpha and Beta stations are marked with filled and unfilled symbols respectively. Array stations and 3-C stations are marked as circles and triangles respectively.

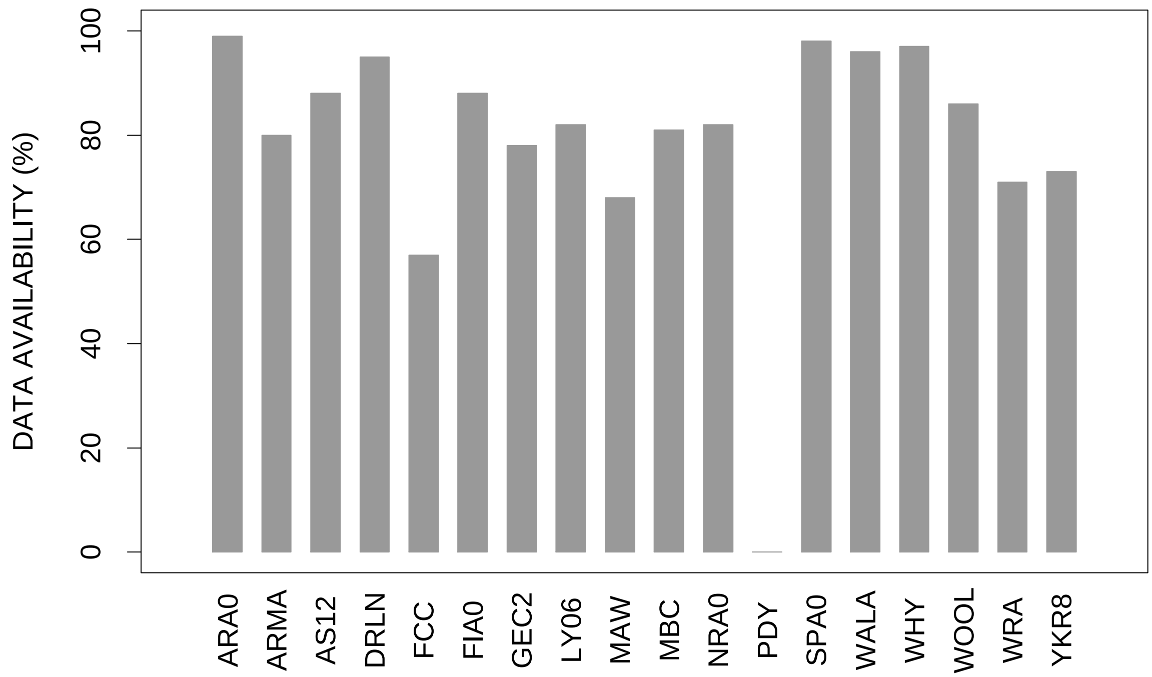

Figure 2. Availability of Alpha station data at the IDC. Values indicate the percent of time during the reporting period for which data were received at the IDC.

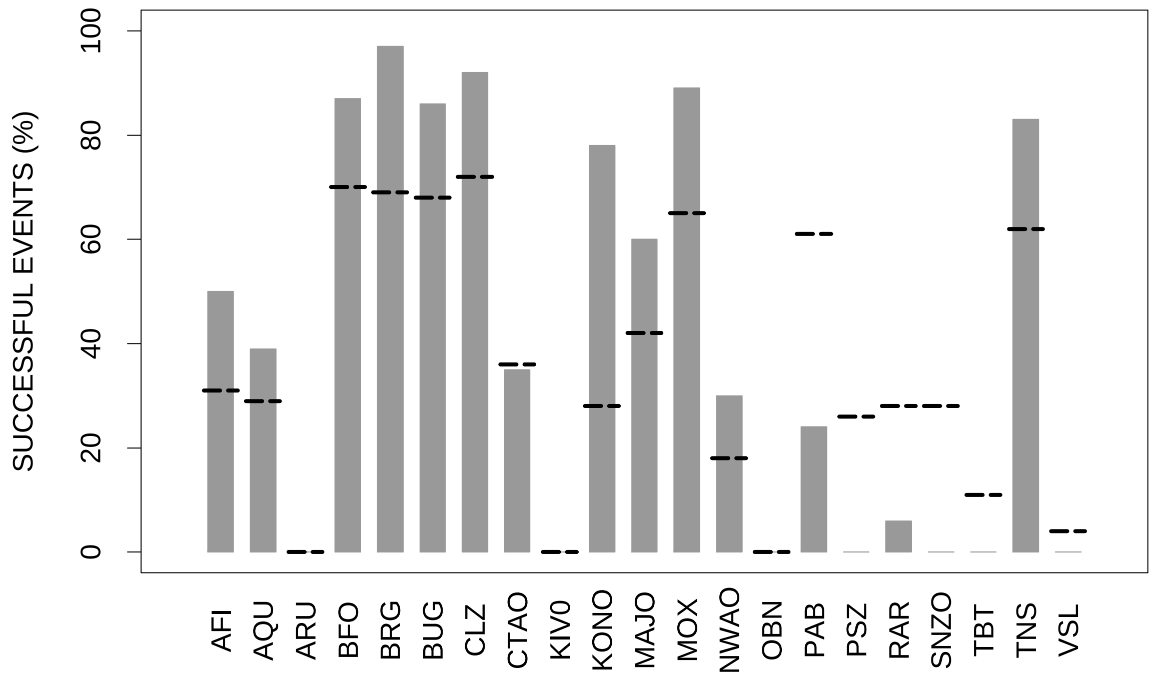

Figure 5. Percentage of times that requests for data from Beta stations were successful for distinct events in the AEL. Dashed lines show averages for the previous Version 0 and Version 1 operation.

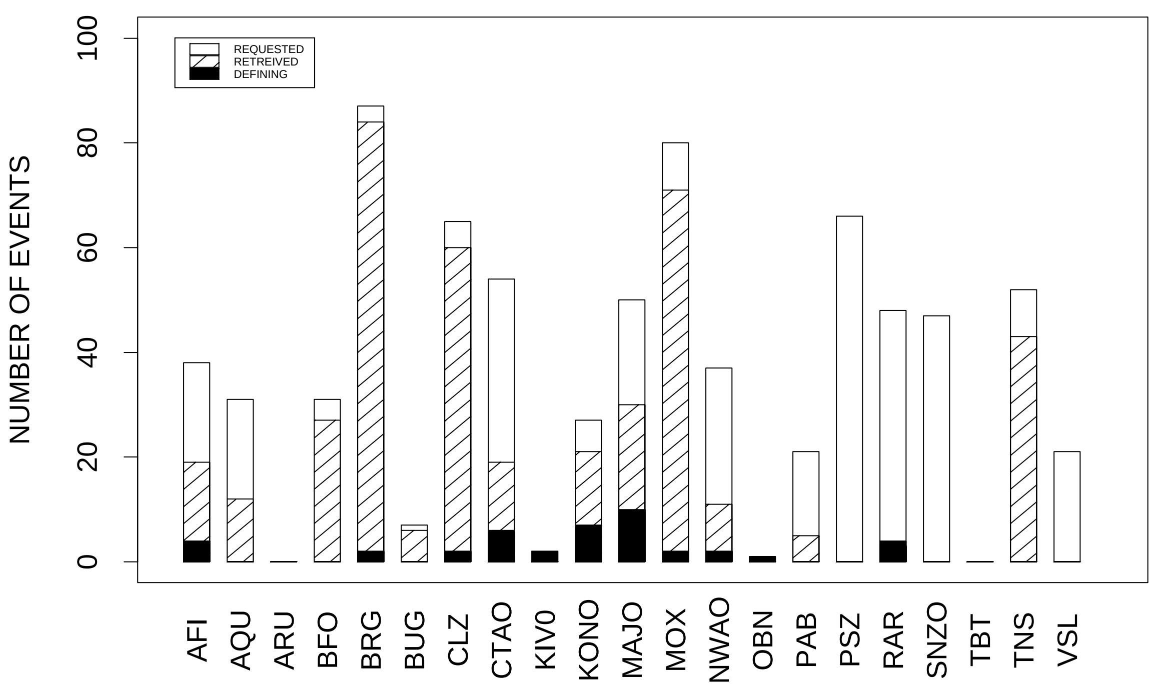

Figure 6. Number of events for which data were requested, actually retrieved and used for defining phases for each of the Beta stations.

–

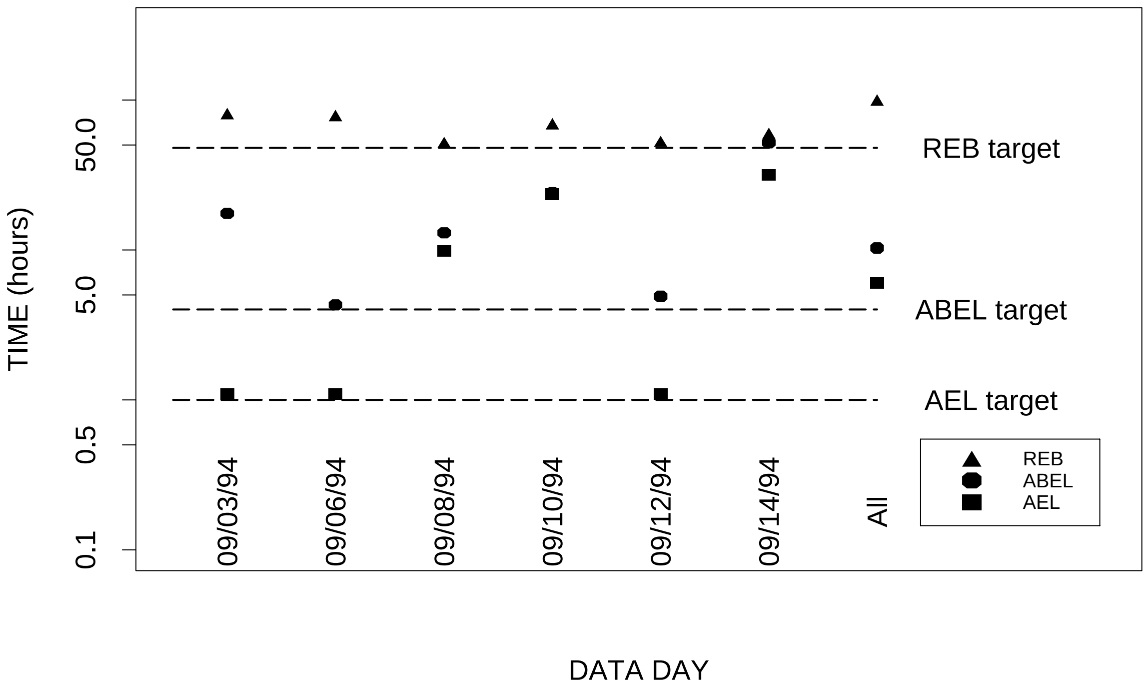

Figure 7. Time of entry of 90% of the events into the data base for the AEL, ABEL and REB for this period compared to previous Version 0 and Version 1 (All). Target times for completion are 1 hour (AEL), 4 hours (ABEL), and 48 hours (REB).

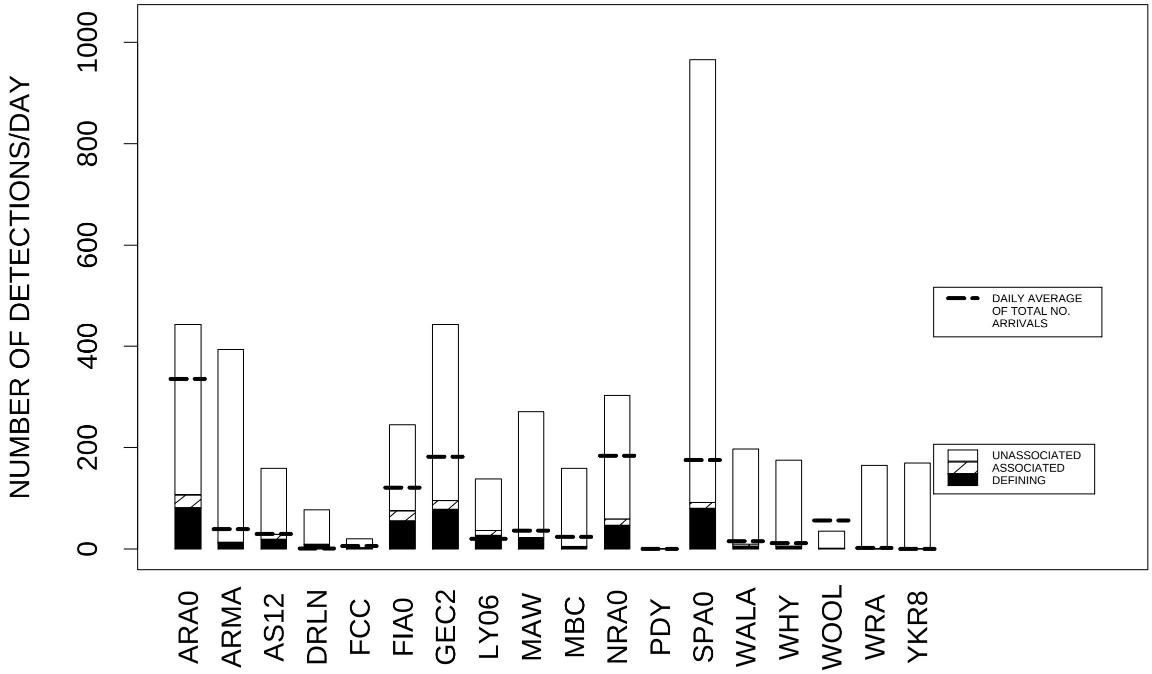

Figure 8. Number of automatic detections per day for each Alpha station. Detections are from the ABEL where each detection is either a defining phase, an associated but non-defining phase or an unassociated phase. Dashed lines show averages for the previous Version 0 and Version 1 operation.

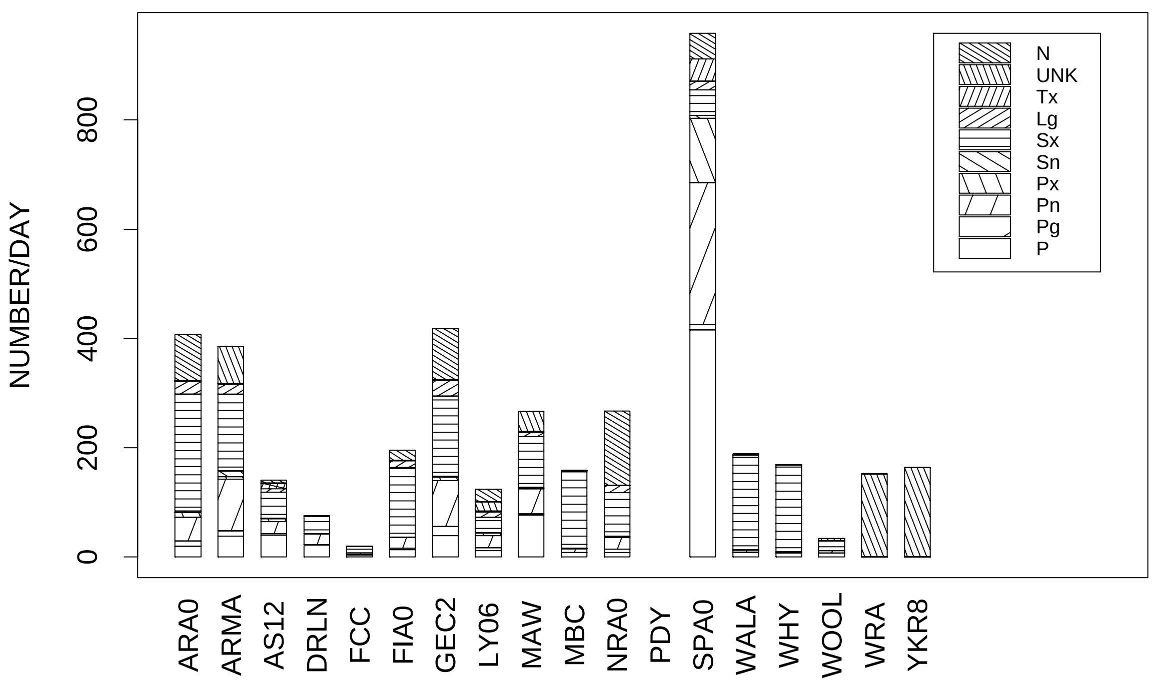

Figure 9. Number of arrivals per day that were unassociated for each Alpha station. Phase identifications are from the ABEL.

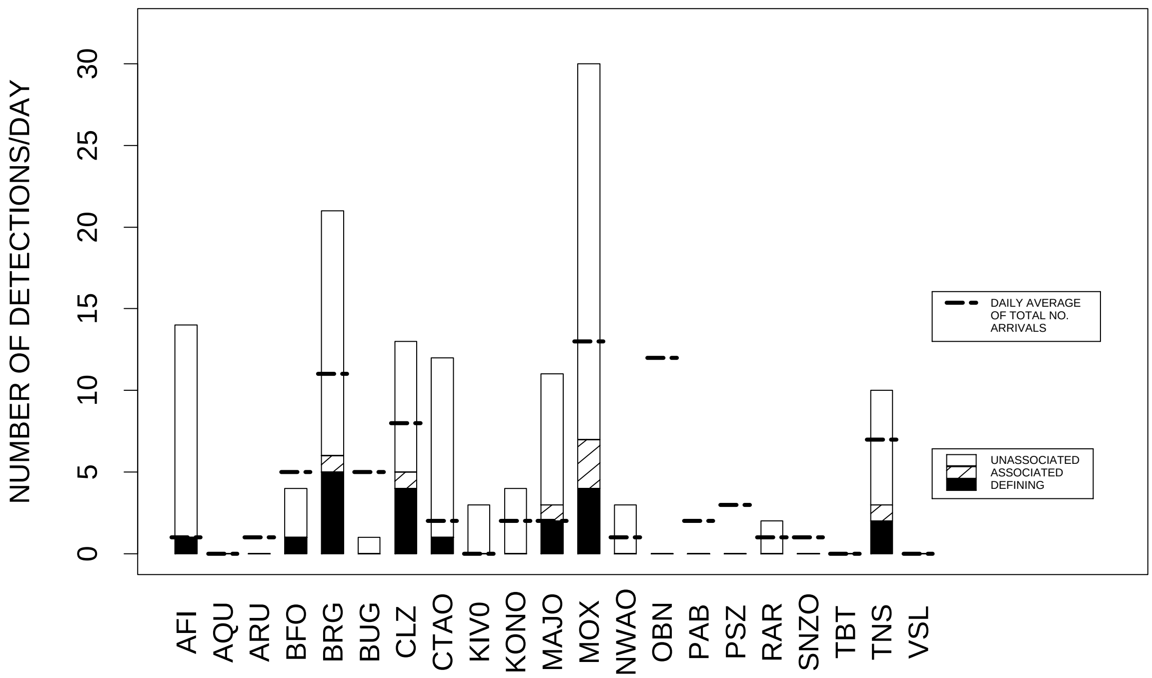

Figure 10. Number of automatic detections per day for each Beta station. Detections are from the ABEL where each detection is either a defining phase, an associated but non-defining phase or an unassociated phase.

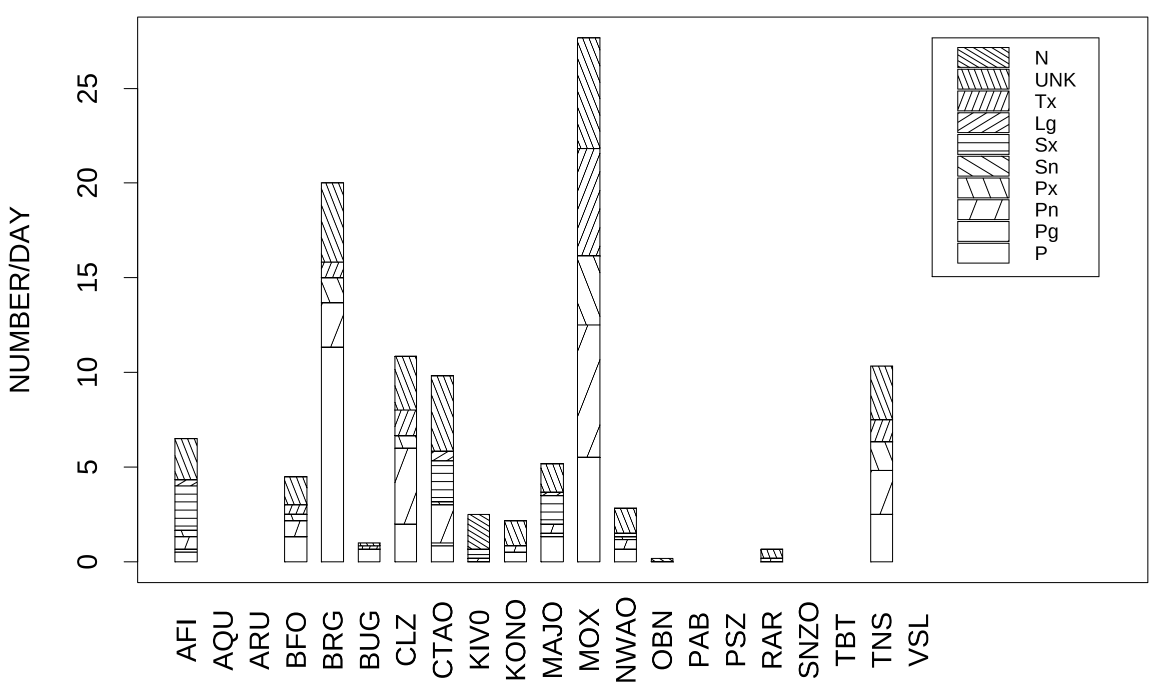

Figure 11. Number of arrivals per day that were unassociated for each Beta station. Phase identifications are from the ABEL.

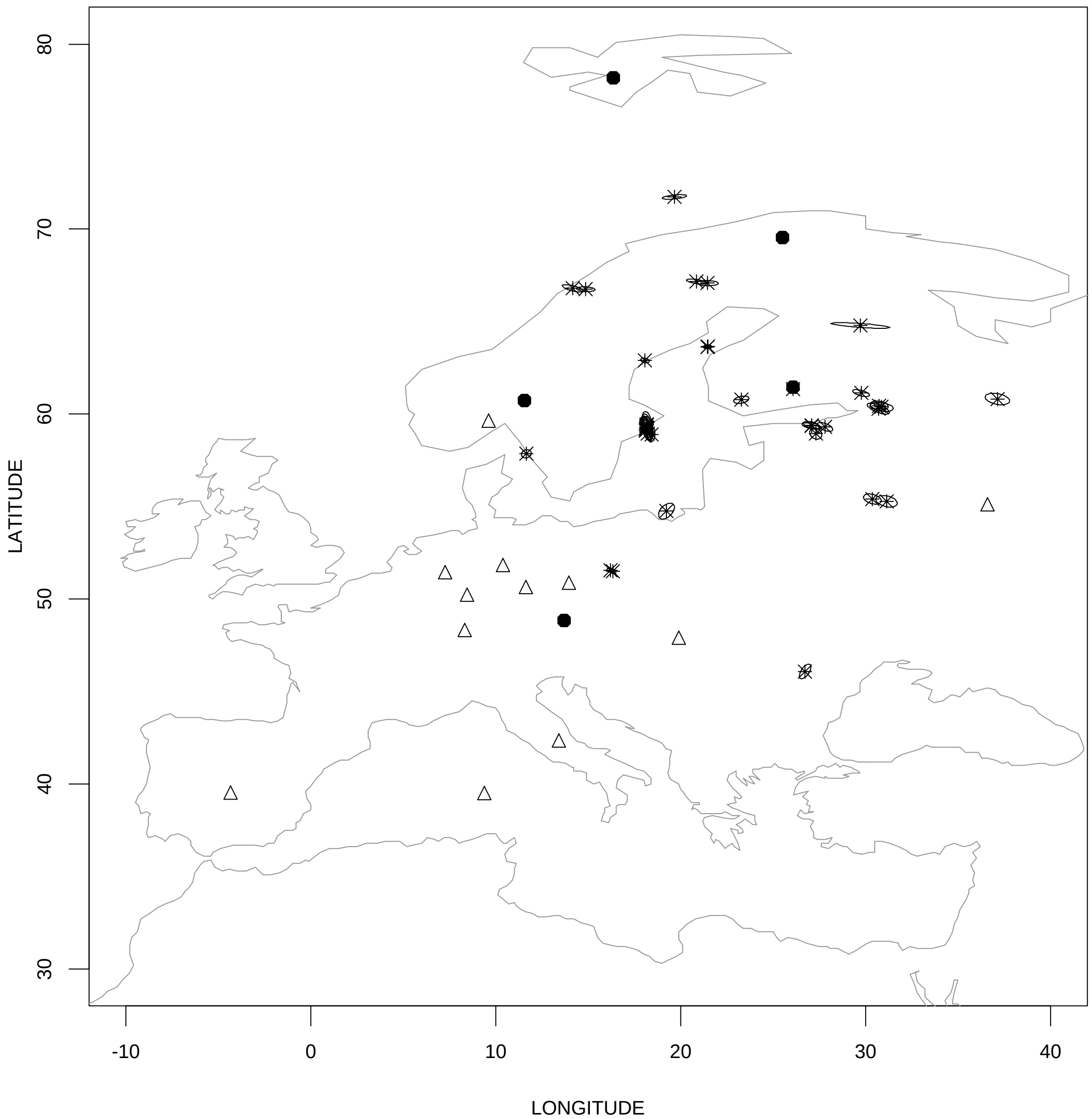

Figure 12. Map of REB events in Europe for the period of this report (asterisks). Ellipses are 90% confidence limits for the current period. For some events, the ellipse is smaller than the asterisk. Alpha and Beta stations are marked with filled and unfilled symbols respectively. Array stations and 3-C stations are marked as circles and triangles respectively.

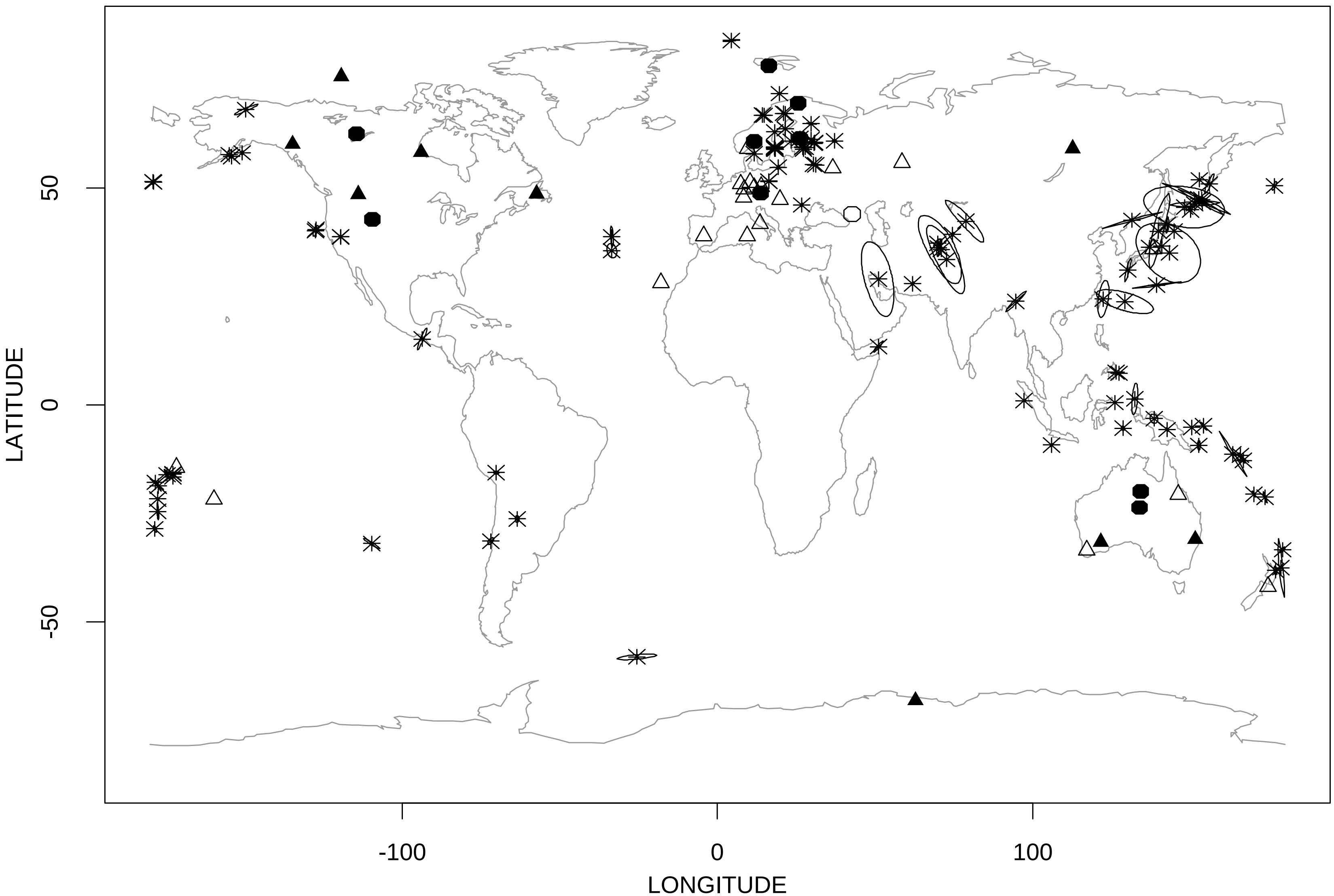

Figure 13. Map of REB events in the world for the period of this report (asterisks). Ellipses are 90% confidence limits for the current period. Alpha and Beta stations are marked with filled and unfilled symbols respectively. Array stations and 3-C stations are marked as circles and triangles respectively.

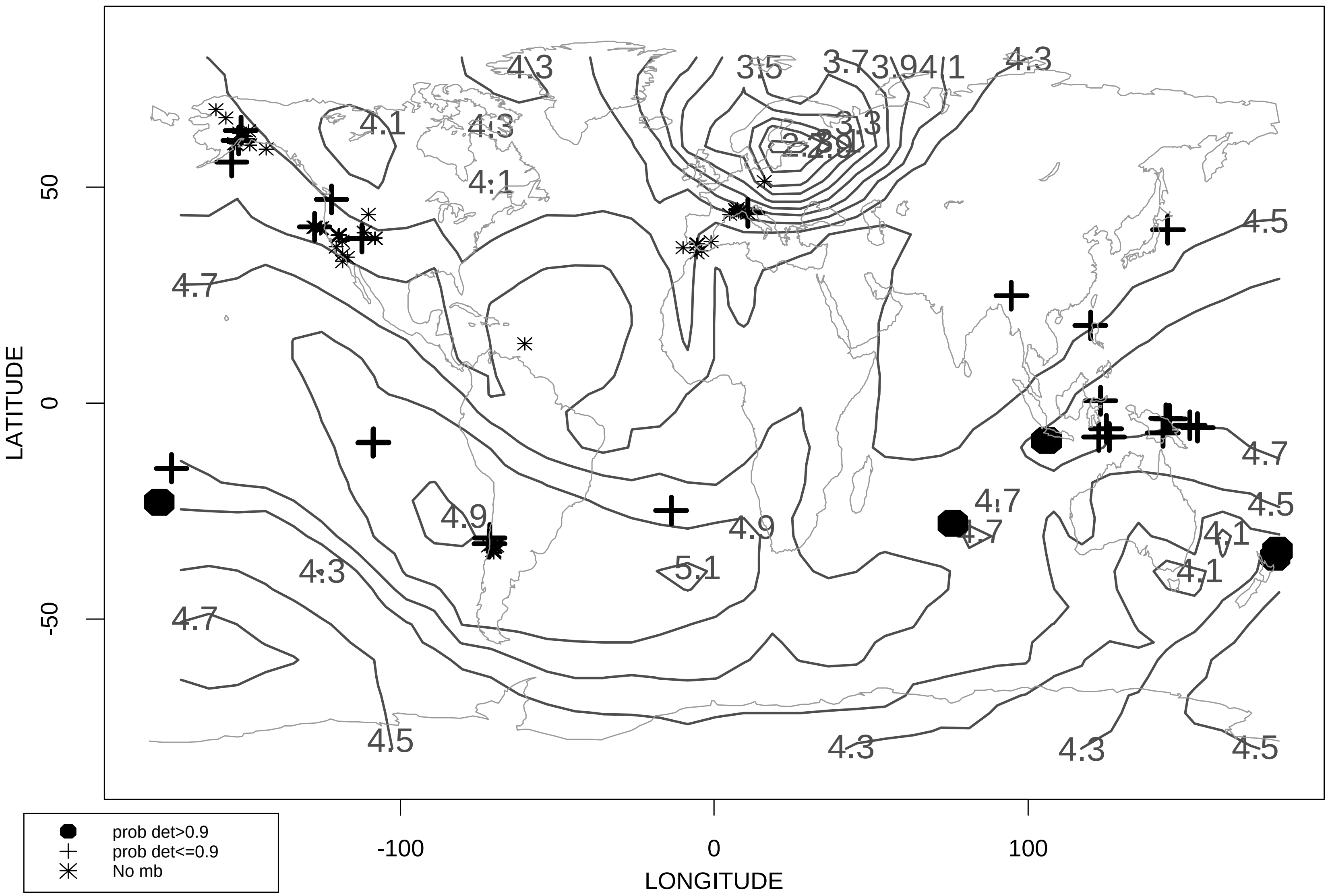

Figure 14. Map of events reported in the Quick Epicenter Determination (QED), but not in the REB. Contours show the estimated detection capability (0.90 probability) for the Alpha network with three P detections.

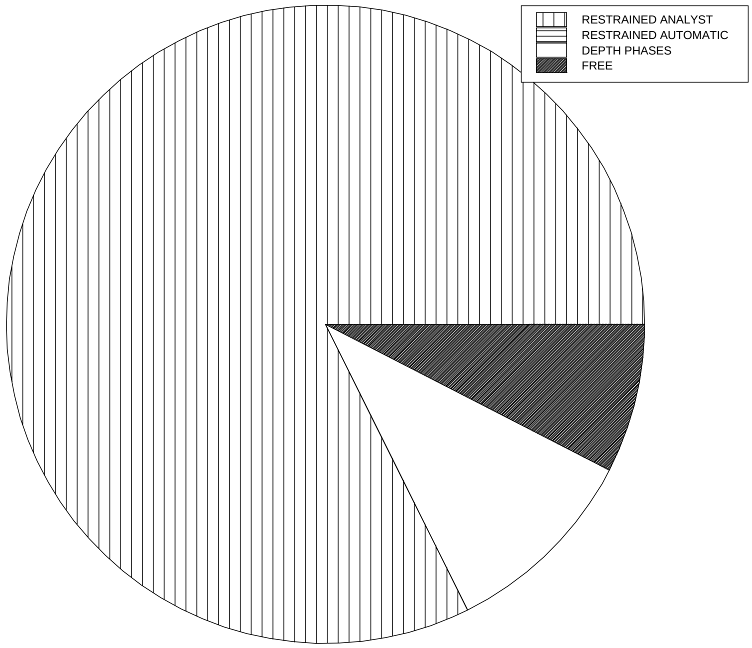

Figure 15. Depth constraints for events in the REB for the current period.

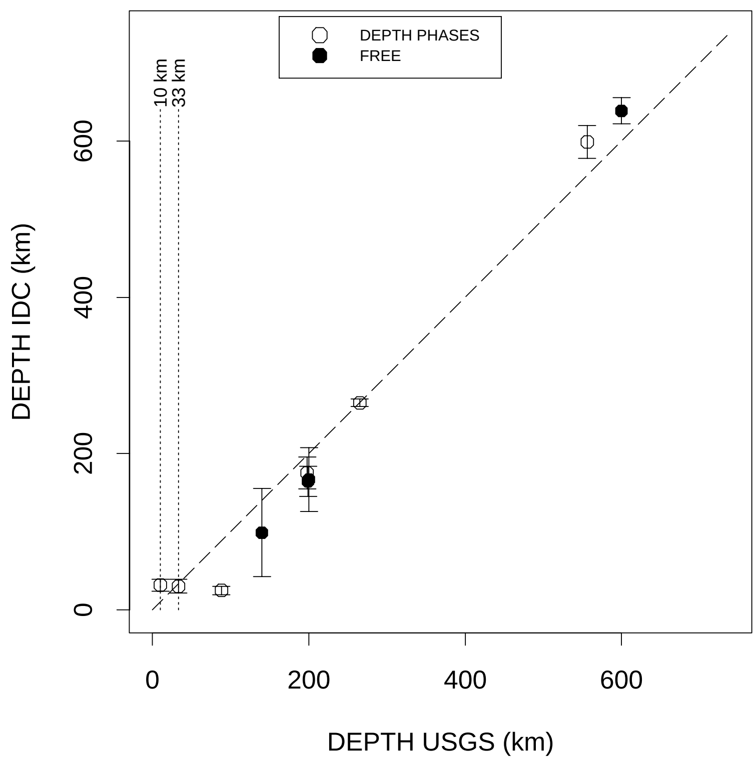

Figure 16. For common events, comparison of unconstrained depths in the REB with depths reported by QED.

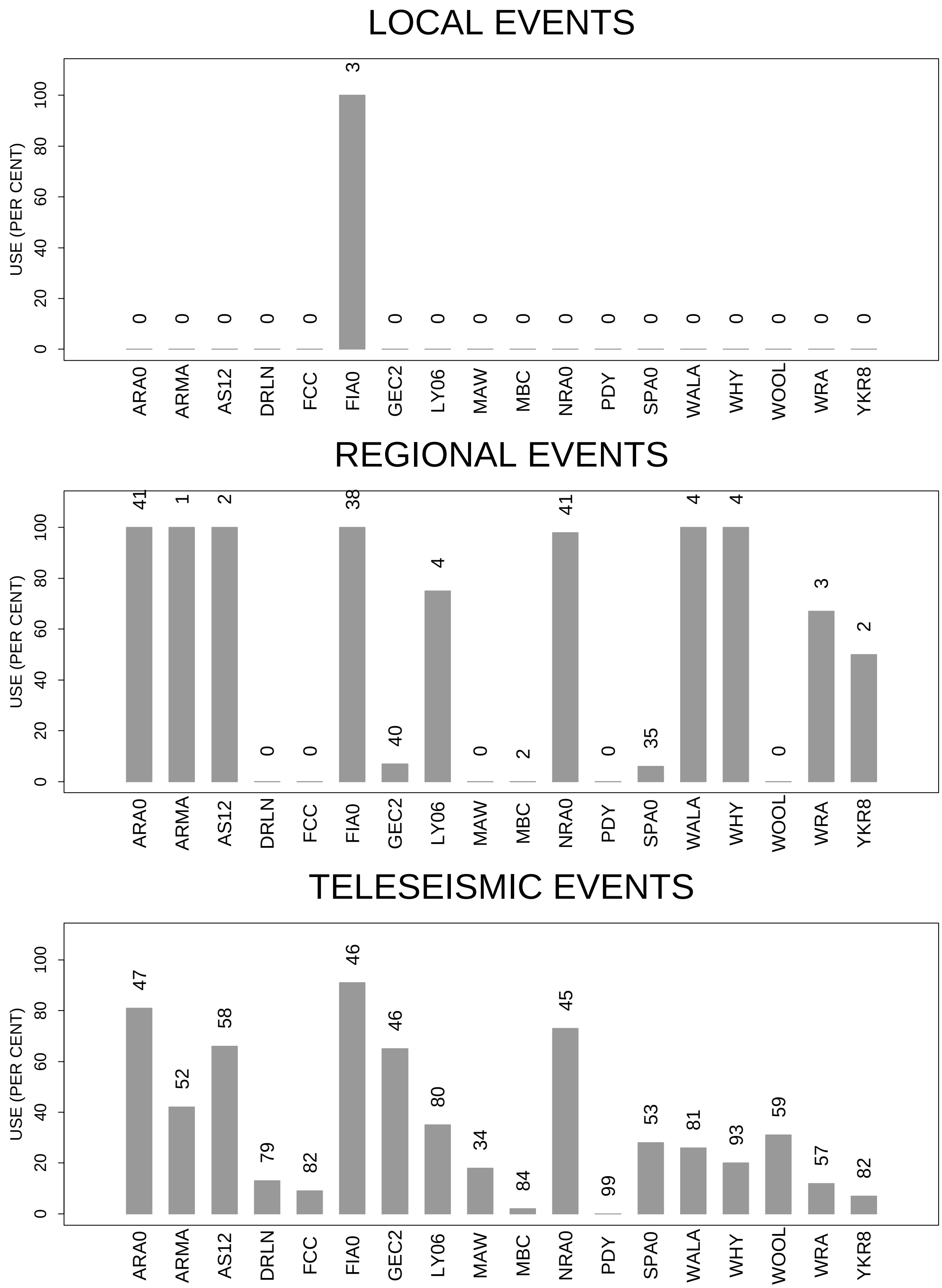

Figure 19. Use of Alpha stations in the REB for events at local ($< 2^o$), regional ($2 - 20^o$), and teleseismic ($20 - 90^o$) distances. The number above each bar represents the number of events within the specified distance range of the station, and the height of the bar is the per cent of that same number for which the station was used in the REB solutions.

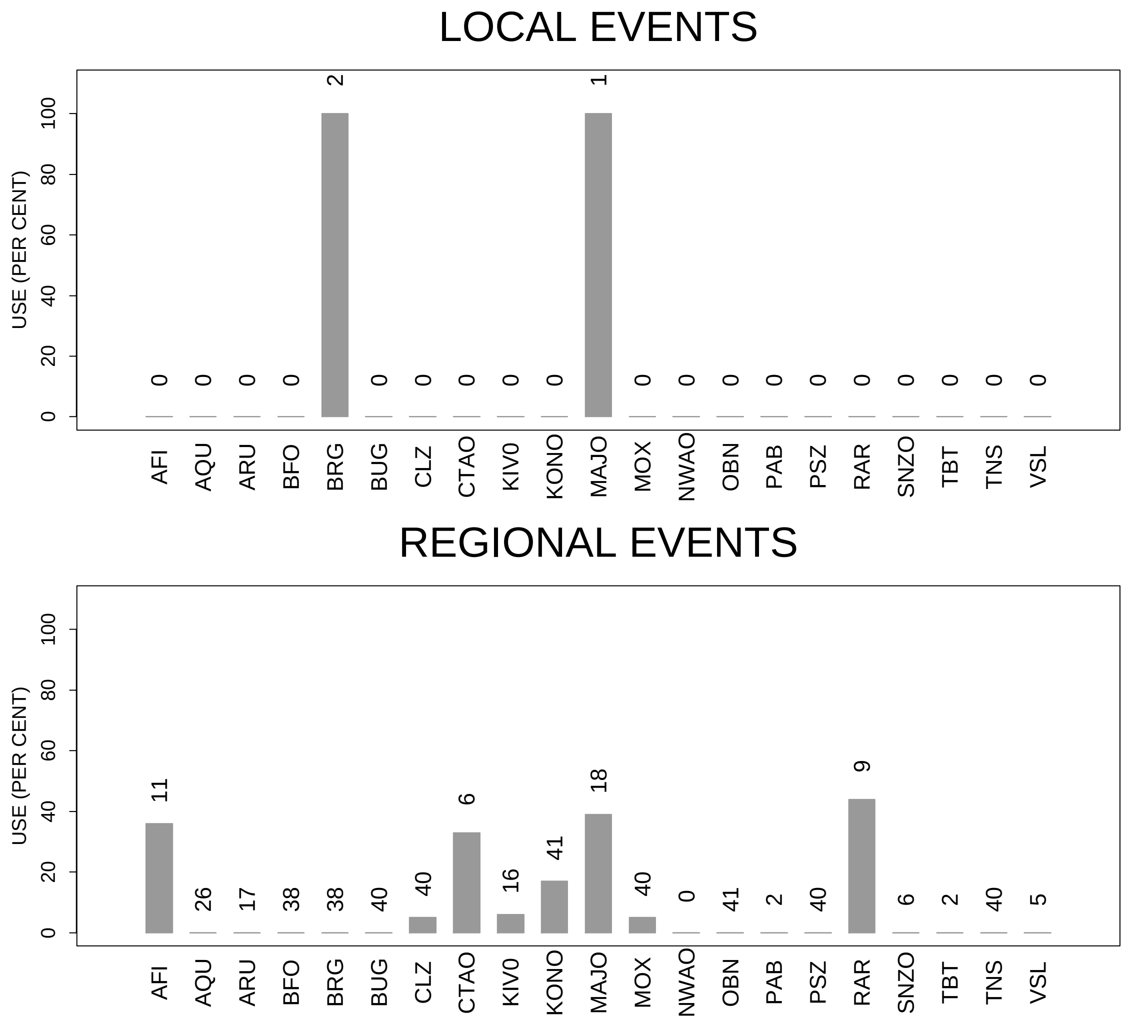

Figure 20. Use of Beta stations in the REB for events at local ($< 2^o$) and regional ($2 - 20^o$) distances. The number above each bar represents the number of events within the specified distance range of the station, and the height of the bar is the percent of that same number for which the station was used in the REB solutions.